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February 28, 2002

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Our Reference: 9351-97

PRELIMINARY AMENDMENT

The Commissioner of Patents
& Trademarks
Washington, D.C.
20231, U.S.A.

Dear Sir:

Re: New U.S. Divisional Patent Application of
United States Patent Application No. 09/592,950
For: CATALYTIC HUMIDIFIER AND HEATER FOR THE FUEL STREAM OF A FUEL CELL
Inventors: Xuesong Chen et al

We are simultaneously filing herewith a divisional application of United States patent application serial number 09/592,950 filed on June 13, 2000. Please enter the following amendment in the divisional application.

In the Specification:

Please insert the following paragraph on page 1, line 4 as follows:

--The present application is a divisional of USSN 09/592,950 that was filed on June 13, 2000 (now pending).—

Please delete the passage from page 4, line 30 to page 6, line 13.

After page 8, line 5, please insert the following as two new paragraphs:

--The stack can comprise an air-breathing stack, including a plurality of channels extending through the fuel cell stack for permitting free flow of ambient air as the oxidant through the fuel cell stack, there being at least one channel for each fuel cell, wherein the catalytic reaction is mounted below the fuel cell stack. The catalytic converter is configured to receive air as an oxidant through the second inlet thereof in excess of the stoichiometric quantity of air required for combustion of fuel within the catalytic reaction, whereby heated and humidified air is discharged from the outlet of the catalytic reaction. The outlet of the catalytic reaction is mounted below the channels of the fuel cell stack,

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whereby heated and moistened air flows upwardly through the channels of the fuel cell stack from the catalytic reactor.

The catalytic reactor can be either generally tubular or it can be disk-shaped, configured for flow of fuel and oxidant generally along the central axis of the reactor.

In the Claims:

Please delete claims 1-12 currently of record leaving claims 13-16 pending in the divisional application.

Please amend claims 13 and 14 as follows:

13. (Once Amended) A method of operating a fuel cell system comprising a plurality of fuel cells, each fuel cell comprising an inlet for fuel, an anode having a catalyst associated therewith for producing cations from fuel, a fuel manifold connected between the inlet and the anode for distributing fuel to the anode, an oxidant inlet means for supplying oxidant, a cathode having a catalyst associated therewith and connected to the oxidant inlet means for producing anions from the oxidant, said anions reacting with said cations to form water on said cathode and an ion exchange membrane disposed between the anode and the cathode, for facilitating migration of cations from the anode to the cathode, while isolating the fuel and oxidant from one another, the method comprising:

(a) supplying oxidant and fuel to the oxidant inlet means and the fuel inlets of the fuel cells for reaction to generate electrical power and heat;

(b) providing a catalytic reactor for promoting reaction of the fuel and the oxidant, supplying the fuel to the catalytic reactor and supplying the oxidant to the catalytic reactor in an amount less than the stoichiometric amount required for the combustion of the fuel to ensure complete consumption of the oxidant, thereby generating a flow of heated and humidified fuel; and

(c) supplying the heated and humidified fuel to the fuel inlets of the fuel cells, for reaction with the oxidant to generate electricity and heat.

14. (Once Amended) A method as claimed in claim 13, which comprises, for initial start-up below a preset temperature, initially supporting fuel and oxidant only to the catalytic reactor to generate a flow of heated and humidified fuel, and passing the heated and humidified fuel through the fuel cells to preheat the fuel cells, and commencing supply of oxidant to the fuel cells, once the fuel cells reach a desired temperature.

Please insert the following new claims 17-25 as follows:

17. (New) A method as claimed in claim 13, which includes:

(a) providing a second catalytic reactor for promoting reaction of the fuel in the oxidant, supplying the fuel to the catalytic reactor and supplying the oxygen to the catalytic reactor in an amount greater than the stoichiometric amount required for the

combustion of the fuel to ensure complete consumption of the fuel and thereby to generate a flow of heated and humidified oxidant; and

(b) supplying the heated and humidified oxidant to the fuel cell for reaction with the heated and humidified fuel.

18. (New) A method as claimed in claim 17, wherein each of the first and second catalytic reactors is generally tubular.

19. (New) A method as claimed in claim 17, which includes supply lines for fuel and oxidant connected to the first and second catalytic reactors, and check valves in the supply lines for preventing back flow of oxidant and fuel.

20. (New) A method as claimed in claim 19, which includes flash arresters in the supply lines for the fuel connected to the first and second catalytic reactors.

21. (New) A method as claimed in claim 19 or 20, which includes a pump for delivering air as an oxidant to the first and second catalytic reactors.

22. (New) A method of operating a fuel cell system comprising a plurality of fuel cells, each fuel cell comprising an inlet for fuel, an anode having a catalyst associated therewith for producing cations from fuel, a fuel manifold connected between the inlet and the anode for distributing fuel to the anode, an oxidant inlet means for supplying oxidant, a cathode having a catalyst associated therewith and connected to the oxidant inlet means for producing anions from the oxidant, said anions reacting with said cations to form water on said cathode and an ion exchange membrane disposed between the anode and the cathode, for facilitating migration of cations from the anode to the cathode, while isolating the fuel and oxidant from one another, the method comprising:

(a) supplying oxidant and fuel to the fuel cell for reaction to generate electrical power and heat;

(b) providing a catalytic reactor for promoting reaction of the fuel and the oxidant, supplying the fuel to the catalytic reactor and supplying the oxidant to the catalytic reactor in an amount greater than the stoichiometic amount required for the combustion of the fuel to ensure complete consumption of the fuel, and thereby to generate a flow of heated and humidified oxidant; and

(c) supplying the heated and humidified oxidant to the fuel cell system, for reaction with the oxidant to generate electricity and heat.

23. (New) A method as claimed in claim 22, for which it comprises, for initial start-up below a preset temperature, initially supplying fuel and oxidant only to the catalytic reactor to generate a flow of heated and humidified oxidant, and passing the heated and humidified oxidant through the fuel cells to pre-heat the fuel cells, and commencing supply of fuel to the fuel cells, once the fuel cells reach a desired temperature.

24. (New) A method as claimed in claim 22 or 23, which includes providing the catalytic reactor as a tubular reactor.

25. (New) A method as claimed in claim 22 or 23, which includes:
supplying air as the oxidant;
providing the fuel cell system as an air-breathing system including vertical channels for flow of air as the oxidant;
and providing only a portion of the air required as the oxidant through the catalytic reactor, with additional air flowing directly through the channels of the fuel cell system.

REMARKS

Firstly, claims 13 and 14 are being amended, simply to put these claims in better form. First, step (a) of claim 13 has been amended to refer to the oxidant inlet means of the fuel inlets of the fuel cells, as mentioned earlier in the claim. Correspondingly, step (c) of the claim now refers to supplying the heated and humidified fuel to the fuel inlets of the fuel cells.

Similar changes are being made to claim 14. Thus, this claim now refers to fuel cells in the plural, and also reference to "moistened" has been replaced by "humidified", simply to ensure complete consistency with the language of claim 13.

New Claims 17 - 25 are being introduced, to cover other aspects of the method, as detailed in the original application. No new matter has been added. For example, claim 17 introduces a feature of a second reactor, to enable both the fuel and the oxidant streams to be humidified. This feature is mentioned at page 7, lines 14 - 17, and elsewhere.

Claims 18 - 21 provide details of the reactor and other elements, preferred for operating the invention. These are all clearly shown and described in the drawings.

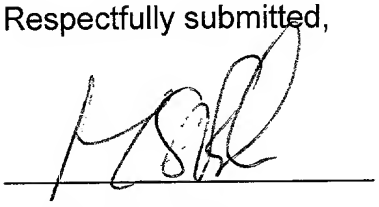
Claim 22 is directed to the alternative of providing the oxidant in excess of the stoichiometric amount to the catalytic reactor, in order to generate a heated and humidified oxidant stream. This aspect of invention was clearly detailed in the original summary of the invention at page 6, lines 14 - 32.

Claims 23, 24 and 25 detail further elements of this aspect of the invention, with these claims corresponding to some of the earlier dependent claims.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "version with markings to show changes made".

Entry of the above preliminary amendment is respectfully requested.

Respectfully submitted,



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/elb
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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

The following paragraph has been inserted on page 1, line 4 as follows:

The present application is a divisional of USSN 09/592,950 that was filed on June 13, 2000 (now pending).

After page 8, line 5, please insert the following as two new paragraphs:

The stack can comprise an air-breathing stack, including a plurality of channels extending through the fuel cell stack for permitting free flow of ambient air as the oxidant through the fuel cell stack, there being at least one channel for each fuel cell, wherein the catalytic reaction is mounted below the fuel cell stack. The catalytic converter is configured to receive air as an oxidant through the second inlet thereof in excess of the stoichiometric quantity of air required for combustion of fuel within the catalytic reaction, whereby heated and humidified air is discharged from the outlet of the catalytic reaction. The outlet of the catalytic reaction is mounted below the channels of the fuel cell stack, whereby heated and moistened air flows upwardly through the channels of the fuel cell stack from the catalytic reactor.

The catalytic reactor can be either generally tubular or it can be disk-shaped, configured for flow of fuel and oxidant generally along the central axis of the reactor.

In the Claims:

Claims 1 – 12 have been deleted.

Claims 13 and 14 have been amended as follows:

13. (Once Amended) A method of operating a fuel cell system comprising a plurality of fuel cells, each fuel cell comprising an inlet for fuel, an anode having a catalyst associated therewith for producing cations from fuel, a fuel manifold connected between the inlet and the anode for distributing fuel to the anode, an oxidant inlet means for supplying oxidant, a cathode having a catalyst associated therewith and connected to the oxidant inlet means for producing anions from the oxidant, said anions reacting with said cations to form water on said cathode and an ion exchange membrane disposed between the anode and the cathode, for facilitating migration of cations from the anode to the cathode, while isolating the fuel and oxidant from one another, the method comprising:

(a) supplying oxidant and fuel to the oxidant inlet means and the fuel inlets of the fuel cells for reaction to generate electrical power and heat;

(b) providing a catalytic reactor for promoting reaction of the fuel and the oxidant, supplying the fuel to the catalytic reactor and supplying the oxidant to the catalytic reactor in an amount less than the stoichiometric amount required for the

combustion of the fuel to ensure complete consumption of the oxidant, thereby generating a flow of heated and humidified fuel; and

(c) supplying the heated and humidified fuel to the fuel inlets of the fuel cells, for reaction with the oxidant to generate electricity and heat.

14. (Once Amended) A method as claimed in claim 13, which comprises, for initial start-up below a preset temperature, initially supporting fuel and oxidant only to the catalytic reactor to generate a flow of heated and ~~moistened~~ humidified fuel, and passing the heated and ~~moistened~~ humidified fuel through the fuel cells to preheat the fuel cells, and commencing supply of oxidant to the fuel cells, once the fuel cells reaches a desired temperature.

The following new claims 17-25 have been added as follows:

17. (New) A method as claimed in claim 13, which includes:

(a) providing a second catalytic reactor for promoting reaction of the fuel in the oxidant, supplying the fuel to the catalytic reactor and supplying the oxygen to the catalytic reactor in an amount greater than the stoichiometric amount required for the combustion of the fuel to ensure complete consumption of the fuel and thereby to generate a flow of heated and humidified oxidant; and

(b) supplying the heated and humidified oxidant to the fuel cell for reaction with the heated and humidified fuel.

18. (New) A method as claimed in claim 17, wherein each of the first and second catalytic reactors is generally tubular.

19. (New) A method as claimed in claim 17, which includes supply lines for fuel and oxidant connected to the first and second catalytic reactors, and check valves in the supply lines for preventing back flow of oxidant and fuel.

20. (New) A method as claimed in claim 19, which includes flash arresters in the supply lines for the fuel connected to the first and second catalytic reactors.

21. (New) A method as claimed in claim 19 or 20, which includes a pump for delivering air as an oxidant to the first and second catalytic reactors.

22. (New) A method of operating a fuel cell system comprising a plurality of fuel cells, each fuel cell comprising an inlet for fuel, an anode having a catalyst associated therewith for producing cations from fuel, a fuel manifold connected between the inlet and the anode for distributing fuel to the anode, an oxidant inlet means for supplying oxidant, a cathode having a catalyst associated therewith and connected to the oxidant inlet means for producing anions from the oxidant, said anions reacting with said cations to form water on said cathode and an ion exchange membrane disposed between the anode and the cathode, for facilitating migration of cations from the anode to the cathode, while isolating the fuel and oxidant from one another, the method comprising:

(a) supplying oxidant and fuel to the fuel cell for reaction to generate electrical power and heat;

(b) providing a catalytic reactor for promoting reaction of the fuel and the oxidant, supplying the fuel to the catalytic reactor and supplying the oxidant to the catalytic reactor in an amount greater than the stoichiometic amount required for the combustion of the fuel to ensure complete consumption of the fuel, and thereby to generate a flow of heated and humidified oxidant; and

(c) supplying the heated and humidified oxidant to the fuel cell system, for reaction with the oxidant to generate electricity and heat.

23. (New) A method as claimed in claim 22, for which it comprises, for initial start-up below a preset temperature, initially supplying fuel and oxidant only to the catalytic reactor to generate a flow of heated and humidified oxidant, and passing the heated and humidified oxidant through the fuel cells to pre-heat the fuel cells, and commencing supply of fuel to the fuel cells, once the fuel cells reach a desired temperature.

24. (New) A method as claimed in claim 22 or 23, which includes providing the catalytic reactor as a tubular reactor.

25. (New) A method as claimed in claim 22 or 23, which includes:

supplying air as the oxidant;

providing the fuel cell system as an air-breathing system including vertical channels for flow of air as the oxidant;

and providing only a portion of the air required as the oxidant through the catalytic reactor, with additional air flowing directly through the channels of the fuel cell system.